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Numerical study of the influence of the degree of undercoverage of the acetabular component reinforced by screw on the load-bearing capacity of hip joint endoprosthesis

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Abstract

© Bolshakov P.V., Tikhilov R.M., Mazurenko A.V., Konoplev Yu.G., Pryazhevskiy R.D., Sachenkov O.A., 2018. The aim of the work is to determine the critical value of the undercoverage of the acetabular component reinforced by a screw. The relevance of this study is determined by clinical practice and the absence of clear recommendations on the tactics of endoprosthesis replacement with an undercoverage of the acetabular component. Numerical studies were performed using the finite element method in the Siemens NX. The degree of dysplasia was evaluated on the basis of the original method of intraoperative measurement of the area of undercoverage of the acetabular component. Calculations were carried out for cups with a diameter of 52, 54 and 56 mm reinforced by a screw. The numerical algorithm for implementing the contact interaction is based on the iterative process of determining the contact zone. Based on the results of full-scale experiments, the bone destruction zone was revealed during the screw installation. Base on this information - the stresses in the bone tissue in the area of the screw mounting were analyzed in the calculations. The dependence of the value of the critical force in the joint on the degree of the undercoverage was obtained in the work. The critical value of the joint force was understood as the lowest force at which a loss of load capacity occurs, identified with an excess of the allowable value of the maximal tangential stresses in the screw mounting area. On the basis of the obtained data, the exponential approximation of the magnitude of the critical force in the joint, recalculated in the patient's mass, from the varying degrees of undercoverage was obtained. The obtained dependence of the allowable undercoverage on the patient's mass allows the surgeon to individually and objectively evaluate the possibility of installing the acetabular component of the endoprosthesis and to decide whether to strengthen it with a screw.

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Keywords

Contact interaction, Dysplasia, Endoprosthetics of the hip joint, Mathematical modelling, Reinforcement of the acetabular component with a screw

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